EUI: WHAT YOU NEED TO KNOW

SERIES ON SUSTAINABILITY **3 of 6**

WHAT EUI SHOULD I EXPECT FOR MY BUILDING?

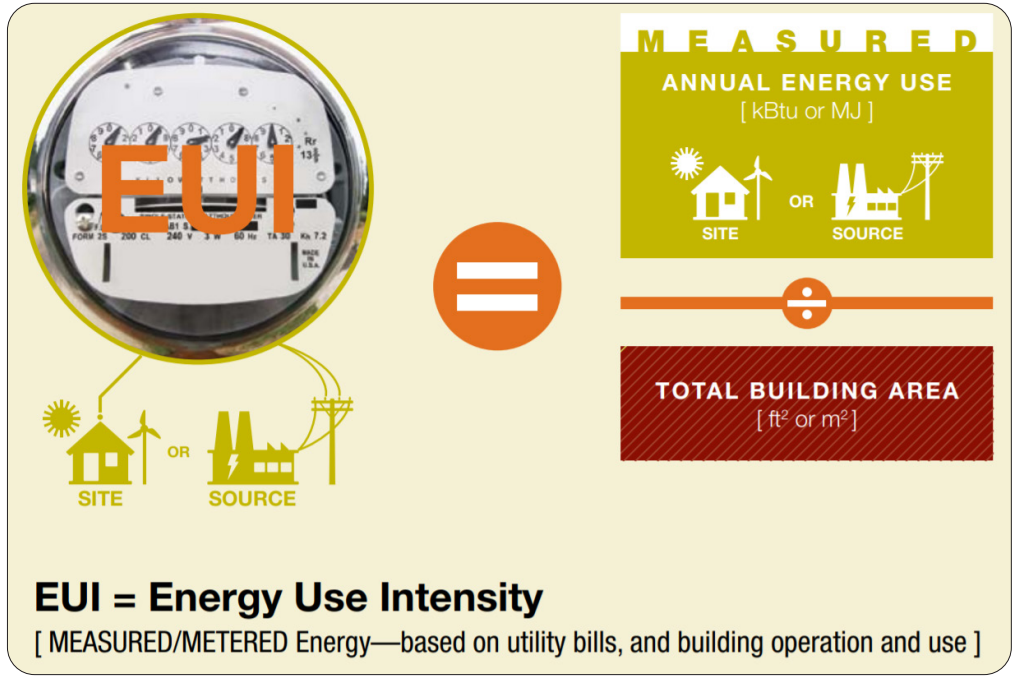
WHAT DOES EUI MEAN AND HOW IS IT USED?

EUI stands for **Energy Use Intensity**, and is the energy consumption of a building for one year in kBTU, divided by the square footage of the building.

We can look at EUI on the "Site" basis, which is the amount of energy consumed by the building and reflected by utility bills, or on a "Source" basis, which includes energy lost during production, transmission, and delivery to the building. In the case of electricity, that would account for efficiencies of the power plants, transmission lines, and ancillary equipment that consumes energy in the grid. Site EUI is a much more common metric because it's easier to calculate and is directly influenced by design decisions. When Site or Source is not specified, we're referring to Site EUI.

We generally look at a predicted Site EUI from energy models, but after a building is occupied for a full calendar year, you can calculate the actual building operating EUI.

Site EUI is the main metric used by the AIA 2030 challenge and Minnesota's SB2030 program. Source EUI has been adopted by the Department of Energy, LEED and the Institute for Living Future as the metric used for determining Net Zero buildings.



BUT... EUI DOESN'T TELL THE WHOLE STORY

How efficiently is space used in a building?

- Smaller apartments may have a higher EUI but house more people;
- Lots of garage area contributes to low EUIs;
- 24/7 operation will show a higher EUI than 8 hrs/day, 5 day/week.

What are the weather conditions?

- These vary year-to-year, so we expect fluctuation;
- A building in San Francisco has lower heating and cooling loads than the same building in Duluth or Albuquerque. (Yes, there are greater total cooling loads in Duluth than San Francisco and greater total heating loads in Albuquerque than San Francisco! San Francisco is very moderate! This is using Degree-Days as measured by ASHRAE).

What are we asking the building to do?

- An industrial building may have an EUI of 400, but 385 of that are all related to process equipment – i.e. the building might not be heated, has low lighting levels, minimal ventilation, and all of the energy is used by "doing stuff"

This is why we always want to compare a building to a benchmark or baseline. For existing buildings we use actual EUI to a benchmark specific to the building. For new construction we always compare energy models relative to a "Baseline building" with the same operation hours, process loads, and weather conditions.

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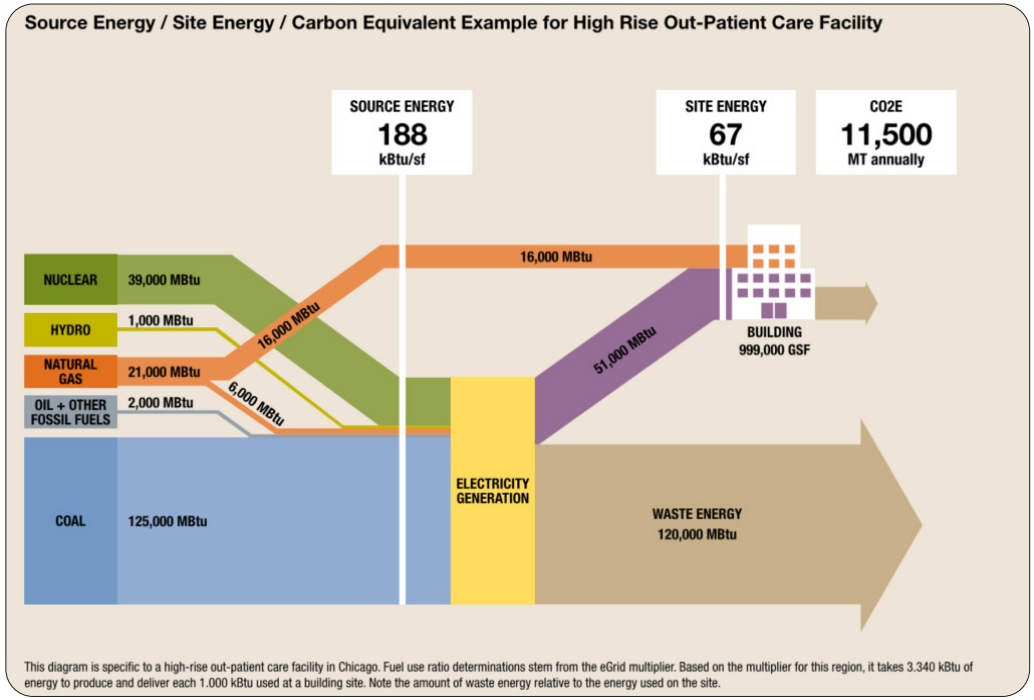

Source Energy and Site Energy

This image demonstrates the difference between Site and Source energy with Source energy including all of the energy inputs for generating electricity, and Site energy only measuring the energy that crosses the site boundary. For example ~44% of energy from coal is lost as heat at the plant, and an additional ~22% of energy is lost in transmission. Source EUI includes those losses, while Site EUI ignores the energy it took to transfer electricity to the building. The electric grid has many sources, so we typically use a blended average of the grid.

Figure 2 – Comparison of Alternate Heating Scenarios

	Building A	Building B	Building C	Building D	Building E	Building F
Heating Fuel	Natural Gas	Natural Gas	District Steam	Electric	Electric	Electric
Heating System	Gas-fired Boiler 90% combustion efficiency 80% system efficiency	District Steam 70% combustion efficiency 55% system efficiency	District Steam 95% system efficiency	Geothermal COP=4.0	Air Source Heat Pump COP = 2.5	Electric Resistance Heat
Heat to Space (MBtu)	1000	1000	1000	1000	1000	1000
Site Energy (MBtu)	1250	1818	1053	250	400	1000
Source Energy (MBtu)	**1313**	**1909**	**1264**	**700**	**1120**	**2800**

Note that the U.S. source-site ratios were applied:
- *Electricity: 1 unit site = 2.80 units source*
- *Natural Gas: 1 unit site = 1.05 units source*
- *Steam: 1 unit site = 1.20 units source*

Alternate Heating Scenarios

EnergyStar publishes national averages of Site to Source ratios for different fuel sources, and this example shows how different fuels would impact the Site and Source energy for the same building.

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BUILDING TYPE	AVERAGE SQUARE FOOTAGE	AVERAGE KBTU/SF	MAXIMUM KBTU/SF
CORRECTIONS FACILITY	565,443	121	181
PARKING: OPEN AIR RAMP	290,085	30	87
NURSING HOME	177,149	156	277
LAB BUILDING	138,238	301	502
TRANSPORTATION	124,888	64	178
OFFICE	105,301	79	590
MAINTENANCE REPAIR SHOP	37,439	97	224
COLLEGE CLASSROOM	32,193	90	103
GYMNASIUM	26,695	76	131
WORKSHOP	22,843	36	138
CONVENTION CENTER	20,429	123	166
COMMUNITY/RECREATION CENTER	18,258	79	79
RETAIL / STORE	8,919	99	163
PARKING: ENCLOSED GARAGE	7,135	9	25
GRAND TOTAL	**60,116**	**59**	**590**

EUI VARIATIONS?

In the operations phase, building EUI varies even more significantly than a modeled building. This is because modeled EUI typically reflects new construction using new equipment and techniques, and we assume all equipment is working as it was intended.

To the left are ranges of average and maximum Site EUI for buildings owned by the state of MN as of 2020.

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